Network Centric Warfare (NCW): the Mechanism for Change

CSC 2003

Subject Area C4

PREFACE

My research started with the intent to understand and determine if Network Centric Warfare (NCW) concepts could stand the challenges of the complexity of operational level of war and brings all the parts into a cohesive unit. I have discovered that the technology required for NCW is the small challenge compared to the change required in the military culture.

I would like to thank my mentors, Dr. Craig A. Swanson and Lieutenant Colonel Zaborowski for their continuous encouragement and support to stay with this research project. Their support and contributions have made this research project possible. Thanks also to the many professionals that have written books and articles on Network Centric Warfare. Though I do not know you personally, your work provided me extensive information from different viewpoints on the subject.

Finally, thanks to my friend, Laura Harver, who inspired me to complete this project and helped me to grow in the process. Thanks to the many that was also cheering for me on the sideline.

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2003		**00-00-2003 to 00-00-2003**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Network Centric Warfare (NCW): the Mechanism for Change	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **United States Marine Corps,Command and Staff College, Marine Corps University,2076 South Street, Marine Corps Combat Development Command,Quantico,VA,22134-5068**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**54**	

EXECUTIVE SUMMARY

Title: Network Centric Warfare (NCW): The Mechanism For Change

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Thesis: NCW is not merely new technology, but a new way of thinking, organizing, and fighting wars in the future.

Discussion: NCW introduces old terminology with refined meanings. First, flexibility and adaptability are defined by the commonality of information and the availability of quality information to make timely decisions. The commonality and velocity of information expands the commanders' courses of action options and streamline information collection process.

Second, disruption is defined by lock-in success for friendly forces while lockout success or limit the plans of the enemy through the increased tempo to engage.

Last, destroying the enemy cohesion is defined by the rapidly executed and highly synchronized physical and information assault without resorting to attrition-style campaigns. The combination of these refined terms allows commanders to adapt to, and exploit, the rapidly changing battle space, leveraging friendly forces fitness while increasing the enemy friction and overall level of disorder.

NCW is a mindset change where classical terminology is refined.

Conclusions: NCW concepts capitalize on the advances in information technology, and will continue to evolve. One of the greatest challenges to NCW is the cultural change required to implement new organizational processes that exploit the advantage gained by NCW concepts. Speed of command, self-synchronization, and thin shooters are not new concepts, but they must be accepted and implemented on a larger scale within DOD. NCW is the construct to facilitate change in the mindset of organizations and the individual within those organizations.

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The Emerging Culture Change

Is Network Centric Warfare (NCW) something new or just old warfare methods wrap in a new package in the age of Department of Defense (DOD) transformation? Is NCW just more technology that promises to solve all the problems that commanders, operators, and organizations face during the time of conflict? NCW is not merely new technology, but a new way of thinking, organizing, and fighting wars in the future. NCW centers on the co-evolution of technology, doctrine, and organization to radically change the style of warfare.[1] Speed of command, self-synchronization, and the concept of thin shooters replace much of the existing lexicon.[2] In the age of military transformation, NCW concepts establish a framework to facilitate an evolutionary cultural change in Navy organizations, processes, and doctrines for future warfare.

This paper will examine NCW concepts and analyze how NCW will impact future warfare. First, the transition from

[1] Information Assurance Technology Analysis Center (IATAC), Measuring Effects of Network Centric Warfare: Exploring Belief Metrics in Warfare, May 2002, 5.
[2] IATAC, 5.

an industrial age to the information age will be reviewed. Second, impacts of information age on military operations will be examined. Third, platform centric and network centric environment, command structure, and organizations will be compared. Fourth, Navy's plans to transition to network centric operations (NCO) will be discussed. Last, future warfare methods including organizational and doctrinal changes required to transition to a network centric environment will be analyzed.

Chapter 2

From the Industrial Age to Information Age

War achieves the objectives by violent and costly means that have encouraged presidents, kings, and military leaders alike to seek ways to reduce its negative impact on their societies. Modern European history provides insight into nations in continuous turmoil and struggle to conquer and control territory. Between 700 and 1000 AD, wartime outweighed peacetime factor about five to one.[3] The conflicts between different empires continued from the sixteen to eighteen centuries, and the continent only experienced short spans of peacetime.[4]

With the continuous outbreaks, European statesmen and military leaders sought new ways to reduce the cost of warfare. Through the need to change the adverse impact of war on European societies, four major changes occurs in the art of war: revolution in tactics, growth in army size, adoption of more ambitious and complex strategies to move larger armies

[3] Geoffrey Parker, *The Military Revolution*, 2nd Edition (Cambridge, UK: Cambridge University Press, 1996), 1-2.
[4] Parker, 2.

into action, and impact on the society.[5] War inflicted pain and extremely high cost to the society at large through extensive collateral damages on the civilian population. Also, the cost to maintain and augment a standing army was a tremendous financial and administrative burden.

The European revolution forced governments' structures and philosophies to change and explore other means to reduce the cost of war. The severe administrative and logistical problems posed by the need to build more fortresses and more warships, and to raise and equip more troops, in effect caused a revolution in government from which emerged, in the eighteenth century, the modern state.[6]

The modern state concept established structure and framework for the society to be an autonomous state and maintain security of their boundaries. The modern state introduced the concept of maintaining and sustaining a stand army for security. Since the eighteenth century, governments have had the task of balancing the need for a standing army and the cost associated with this benefit.

[5] Parker, 1-2.
[6] Parker, 2.

With the increased cost, the study of the science of war has become a mean to discover new approaches to warfare.[7] Wars are fought in three dimensions: force, space, and time. The first dimension of force is defined as the tangible dimension of military power, which is measured by the lethality or combat power of a particular unit or [weapon] platform.[8] The second dimension of space captures the battle space volume, which includes the physical world (Euclidean space of forward/backward, left/right, and up/down).[9] The third dimension of time involves the tempo of the action in war. These dimensions continue to be influenced by the many technological advances from the industrial and information ages.

War is a product of the age.[10] Technological advances of each age have been used to improve warfare strategies and reduce the cost of war for the side with superior technology. As an example, the industrial age introduces factories and machinery

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[7] Parker, 1-2.
[8] IATAC, 16.
[9] IATAC, 16.
[10] David S. Alberts, John J. Garstka, and Frederick P. Stein, *Network Centric Warfare: Developing and Leveraging Information Superiority*, 2nd Edition revised, (Washington, DC: CCRP Publication 1999), 1.

capable of mass-producing weapons such as tanks, battleships, and aircrafts. The information age brings improvements in effectiveness of kinetic weapons, through the use of global positioning satellite (GPS) advance.[11]

The industrial and information ages have brought significant improvements to the time and space dimensions of war. The introduction of the horse, railroad, battleship, automobile, aircraft, and telecommunications enables the growth of the geographical area of responsibility and spatial disposition of combat units.[12] Improvements in information technologies and telecommunications have radically altered the spatial aspect of warfare, creating a paradigm shift from centralized to distributed operations.[13] In the age of transformation, the Department of Defense (DOD) and the Navy are embracing technology as the solution to reduce the impact and cost of war.

Changes in future warfare are an outgrowth of fundamental changes in society from the industrial age to the information age. The transition to the

[11] IATAC, 16.
[12] IATAC, 17.
[13] IATAC, 17.

information age has caused a dominion effect in economics, information technology, and business processes and organizations. The fundamental changes are the shift from platform to the network; organizations no longer act independently but as integral part of continuous adapting ecosystem.[14] In the information age, power comes from a different place, is used in different ways, and achieves different effects than it did before.[15]

The Information Age changes the expectations in the three dimensions of war. With technology such as Global Positioning System (GPS), timely and accurate information exchange between sensor and shooter increases the probability of locating, classifying, and hitting the desired targets.[16] In the past, force was measured in terms of sheer mass; in the future, force will be measured more in terms of precision effects.[17] The advances in IT and telecommunications allows disaggregated network of sensors, command

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[14] Arthur K. Cebrowski and John J. Garstka, "Network Centric Warfare: It Orgins and Future," Proceedings, URL: <http://www.usni.org/Proceedings/Articles98/PROcebrowski.htm>, Accessed 10 October 2002.
[15] Paul R. Kaufman, "*Sensor Emerge As More Crucial Weapon Than Shooters*," IEEE Spectrum, URL:<www.spectrum.ieee.org/EWBONLY/resource/jul02/net.html>, Accessed 03 March 2003.
[16] IATAC, 16
[17] IATAC, 16

centers, and weapon system for greater dispersion of combat forces while maintaining situational awareness, thus enabling greater mobility and survivability.[18] The time dimension has contracted from days to hours and minutes.[19]

With the availability of accurate, timely and relevant information, the spatial dimension of war has become subordinate to the time dimension. The ability to act in the shortest amount of time in warfare can result in a decisive edge in combat operation.[20] The improvement in the time dimension has established the foundation for network centric warfare. (See Figure 1) Time is one of the key factors for success in NCW.

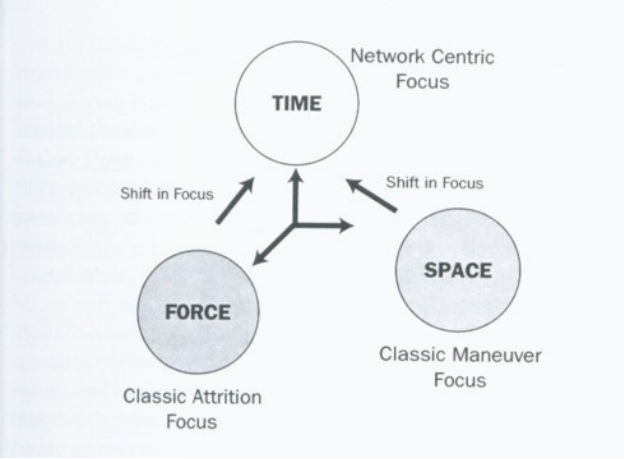

Figure 1. NCW shifts focus to temporal dimension
Source: Measuring the Effects of Network Centric Warfare: Exploring Beliefs Metric in Warfare, May 2002

[18] IATAC, 17.
[19] IATAC, 16.
[20] IATAC, 18.

Joint Vision 2010 and 2020 state that the information age set the stage for a change in warfare strategies. The initial change is the shifting of the primary focus from attrition to maneuver. Attrition warfare achieves victory by eroding the enemy's strength with superior mass and killing power and annihilating them through complete destruction and occupation.[21] Attrition warfare centers on locating and destroying a series of targets with the aim of obliterating the enemy's material strength.[22] Armed forces match their capabilities or weapons and fight until the opponent material strength is ultimately destroyed. Attrition warfare emphasizes armies fighting until the opponent crumbled under the pressure of the mass of force against the multiple objectives.

Attrition warfare victory comes in the force dimension where weapons platforms generate the combat power.[23] The ability of this combat power to inflict physical damage has formed the basis for platform centric warfare (PCW).[24] PCW is a direct combat power approach with an objective to qualify and quantify combat power through

[21] IATAC, 28.
[22] IATAC, 20.
[23] IATAC, 23.
[24] IATAC, 23.

analysis of the platforms that directly generate power.[25] The result of platform confrontation is attrition, with one or more sides suffering physical damage.[26] As war is a product of the age, attrition warfare is losing its preferred status within American military doctrine as technology evolves.

Attrition warfare war has dominated the American military doctrine, throughout the 20th Century.[27] Attrition warfare is an effective way to win wars and prove successful for George Washington during the American Revolution. Though attrition warfare has been effective for many conflicts, governmental leaders and society as a whole seems to be less willing to pay the cost require to maintain the large military forces and weapons. The change in government and society is evidenced by multiple reductions in defense spending for personnel and weapon systems over the last decade.

Today, the pendulum has swung toward maneuver warfare to reduce the cost of warfare. Maneuver is defined as employment of forces on the battlefield through movement in combination with fire, or fire potential, to achieve a position of advantage with

[25] IATAC, 23.
[26] IATAC, 23.
[27] IATAC, 23.

respect to the enemy in order to accomplish the mission.[28] The primary goal is to generate systematic disruption and create enemy friction through rapid, violent attacks against key center of gravity.[29]

The tenets of maneuver warfare are:

- Preemption (defeating or neutralizing the enemy before the fight);
- Dislocation (rendering the enemy's strength irrelevant by removing the enemy from a decisive point in function, space, or time); and
- Disruption (neutralizing the enemy by successfully attacking or threatening his center of gravity)[30]

Maneuver warfare is an indirect approach that focuses on the intangible elements of war such as the enemy units' cohesiveness, command and control, and situational awareness.[31] Speed and surprise are the key elements. Maneuver warfare avoids the strongly held positions and attack in unexpected areas. The goal of maneuver warfare is to inflict damage on the enemy while minimizing damage and loss to the striking units.

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[28] IATAC, 23.
[29] IATAC, 24.
[30] IATAC, 25.
[31] IATAC, 25.

NCW takes a holistic approach for war fighting based on maneuver warfare tenets and capitalizes on the technological advances with distributed computing and networks. NCW makes a fundamental shift from independent entities or platforms to a system approach where the actions of one component affect the whole system. NCW does not remove the fog and friction of war, but reduces them by integrating all the moving parts into a more robust and effective fighting team. Weapon platforms will be an integral part of the whole because the sum of the platforms will produce a greater effect than the independent platforms according to Metcalf's Law. Metcalf's law states that the value of a network increase exponentially as the number of users increases while networking cost increase linearly.[32] The information technologies available today brings the multiplying factor of Metcalf's law to war fighting through the NCW concepts.

For centuries, wars have levied heavy cost on societies' government structures and civilian population. To lessen the burden and reduce the cost of warfare, military leaders have used the

[32] IATAC, 8.

technologies of the industrial and information ages to fight and win wars in more effective and efficient ways. The character of warfare was influenced by the society and the age. The industrial age brought attrition warfare to the forefront, and the information age caused a shift to maneuver warfare. IT advanced enable commanders to fight war differently in the future.

Chapter 3

Impact of Information Age on Military Operations

Arising from fundamental changes in American society, businesses, and military operations will capitalize on the advances and advantages of information technology.[33] Military operations throughout the centuries have been impacted and changed by the technologies such as tanks, ships, aircrafts, and radios. In time past, technology has also sparked changes in military doctrine and organizations. During World War II, German forces used existing technology such as tanks, aircrafts, and radios and coupled them with changes in doctrine and organization, providing the Germany Army a decisive edge over Allied armies [in the opening months].[34]

War fighting is a complex mission with inherent characteristics of uncertainty, fog, and friction. Statesmen and military leaders throughout history have sought means to improve strategies and resources to minimize the effects of these timeliness characteristics. Technology has traditionally been the avenue sought for solutions and answers to the dilemmas faced in war. As seen in other ages, the advances in information age have

[33] Cebrowski and Garstka, 1.
[34] IATAC, 24.

enabled war fighting to evolve over time. Computers, network and improved telecommunications technologies are at the heart of future warfare, NCW.

NCW founders compare military operations to the business model. Within businesses, a fundamental shift has occurred to increase the return on investments. Information technology has been the prime enabler for businesses to realize the increase in wealth. Though only a small fraction of the economy (3% percent in 1996), information technology sector has been the largest contribution to growth in gross domestic product.[35]

Like businesses, Department of Defense (DOD) has also recognized and invested billions of dollars in information technologies (IT) over the last twenty years. The DOD IT investments have centered on utilizing network and telecommunications technologies to establish global information infrastructure (GII) since 1980's.

Information technology has evolved over the last forty years and significantly impacts how businesses and military conduct operations. In the information age, time is one of the dominant factor for measuring effectiveness and efficiency of an organization. Businesses and the military are using IT advances to revolutionize their operations.

[35] Cebrowski and Garstka, 2.

The businesses have transformed their operations through the use of the advances in information technologies, which are called revolution in business affairs (RBA).[36] RBA is a paradigm shift from hardware-centric to a network centric environment, which emphasizes Metcalf's law.[37] RBA has started new dynamics of competition that are based on increasing returns on investment, competition within and between ecosystems, and competition based on time.[38] RBA has identified a key concept, shift from platform-centric to network-centric, that will be used to implement NCW. IT advances will enable the successful implementation of NCW concepts.

In the 1960s and 70s, the business community moved toward centralized computer operations. During this era, robust computing power was very costly and not readily available to a limited group of organizations. Businesses were encouraged to invest in centralized operations and closed systems with minimal links to external business partners. Large scientific organizations, data processing centers, and the federal government housed rooms and rooms of hardware to provide data processing services for others organizations and businesses. This mainframe centric

[36] IATAC, 8.
[37] IATAC, 8.
[38] Cebrowski and Garstka, 2.

approach used proprietary system software and users' applications, which required a significant investment in specialize training and equipment, facilities, and personnel. [39] The data processing centers were independent and autonomous units with their own management structures. Sharing information was limited if any. The customers had minimal insight into current or real-time information. Leased lines from communication vendors were used to connect external locations. End users had no ability to manipulate data at their level. All processing was done at a central location. Information flow could take months.

The 1980s and 1990s were characterized by the proliferation of personal computers (PC). Computing power became available on microchips that had the capacity of mainframe computers. The PC was a smaller unit with all processing components located in one unit. The proliferation of PCs promoted a phenomena change in the business and DOD. The PC centric era emphasized decentralization and localized system operations. Personal computers pave the road for diversity of computing resources and user applications. No longer were businesses tied to centralized processing only. Robust computing

[39] Mainframe centric model is where the computing power was hosted in mainframe computer in a central location.

power had moved from sacred rooms to the desktops. The advent of microchip opened the way for software to be embedded in weapon systems allowing control from a distance. Microchip technology also helped the surge of guided ammunitions enabling the delivery of weapons from a distance platform. As example, microchip technology directly impacted the development of computerized combat information centers (CIC) aboard Navy ship and aircrafts. Naval Tactical Data System (NTDS) on ships was the first almost-universal kind of naval command aid with the digital link (Link 11) between ships, which made it possible for all of them to share a common picture.[40] Also, the Joint Tactical Information Distribution System (JTDS) and Link 16 became a reality. JTDS and Link 16 gave pilots an airplane wide area picture that a ship's tactical action officer got via Link 11.[41]

As PCs made robust computing power available in one small unit, businesses and the DOD developed their organizational computing systems based on their unique requirements and assessment of available system characteristics. UNIX, disk operating system (DOS) and later Windows, and Macintosh are the primary operating

[40] Friedman, 35.
[41] Friedman, 34.

systems. Numerous user applications such as word processors, databases, and other specific developed applications are based on one of the primary operating system. These developments [different operating systems] introduce problems such as decreased interoperability and often increased the complexity of communicating between two different computing platforms [UNIX and DOS/Windows].[42]

Faced with extensive maintenance and operating expenses of localized systems, businesses sought ways to address the growing concerns with interoperability and communications. Also, the growing needs to share computing resources across organizational boundaries with partners, suppliers, and other business entities occurred. To address the growing concerns, client-server architecture and Internet technologies were introduced. Client-server architecture emphasized distributed computing environments where applications and data were downloaded locally from network servers on an as-need basis, utilizing high bandwidth transmission pathways and lower cost thin clients operated by end user.[43] Client server architecture and Internet technologies established a pathway for network centric operations.

[42] IATAC, 5.
[43] IATAC, 7.

Technologies such as transmission control protocol/Internet protocol (TCP/IP), hypertext transfer protocol (HTTP), and hypertext markup language (HTML) have established protocol or defacto standards that establish an environment for different computing platforms to communicate. With these technologies, information content is now created, distributed, and easily exploited across the extremely heterogeneous global computing environment.[44] The fundamental paradigm is most obvious in the explosive growth of the Internet, intranets, and extranets.[45]

Network technologies and radical process reengineering offer more efficient supplier-to-customer linkages, decentralize decision-making, enable distributed operations (e.g., the virtual office), and dramatically compress the business planning cycle from months to days.[46] Technological improvements radically alter existing business concepts of time and space, change organizational structures and behavior, and fundamentally transform traditional business processes.[47] Network centric operations become the catalyst for change in the business industry and introducing a new mindset for business entities within the system.

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[44] IATAC, 3.
[45] Cebrowski and Garstka ,3.
[46] IATAC, 8.
[47] IATAC, 8.

Businesses are no longer single entities acting independently, but part of a larger system of like entities working together to accomplish their missions, simplify operations, and reduce cost.

Mission accomplishment, complexity, and cost are the driving factors for the businesses to revolutionize the way they conduct the business increasing a return on their investments. Businesses recognized information technologies as their means to a desired end. The network centric model became the means to the end. Network centric computing became more than a technological enhancement: it changed the fundamental paradigm of conducting business.[48]

Understanding the critical need for dispersed units to communicate and share across organizational boundaries, DOD implement network infrastructure to support the war fighter. Joint Vision 2010 is the driving force for the telecom and networking initiative for the future of warfare.[49] The architectural plan for the new network called for the linking of all military communications assets, including military commercial satellite communications, leased telecom services, dedicated DOD

[48] IATAC, 8.
[49] Bob Brewin, "DOD lays groundwork for network-centric warfare," Federal Computer Week, URL<http://spica.gl.nps.navy.mil/netusw/>, Accessed 12 October 2002.

networks, and mobile networks.[50] Today, Unclassified Internet Protocol Network (NIPRNET) is the primary means for DOD organizations to connect to the Internet and communicate with DOD organizations. NIPRNET is one component of the Global Information Infrastructure (GII) that has established the network for NCW.

Navy leadership realizes there are benefits to be gained by studying the revolution business affairs. Though military and business leaders have different objectives, both leaders share similar principles and challenges. Fundamentally, both military and business leaders are faced with the cost of doing business. The business world is motivated by return on their investment. Similarly, military leaders have the same motivation, but their increase return on investment is measured by the reduction of causalities on the battlefield.

[50] George Leopold, "Networks: DOD's First Line of Defense," Electronic Engineering Time, URL< http://www.techweb.com/wire/news/1997/10/1013dod.html>, Accessed 12 October 2002.

Chapter 4

Evolution of Warfare

Warfare is a complex and costly endeavor. The character of warfare has changed as a result of fundamental shifts within society and complex organizations. These shifts have focused on battle space awareness and knowledge, command and control (C2) and decision-making, and execution in the information age. Within the military, there is a shift from platform centric warfare/attrition model to network centric/maneuver model. In this section, PCW and NCW will be evaluated and compared based on the advances in IT.

Platform Centric Warfare

Platform centric warfare (PCW) focuses on the platform, or weapons system, as the focal point of combat.[51] A combat platform can be any weapon or system that inflicts physical damage upon an enemy (e.g., tanks, ships, aircraft, artillery, and munitions). Platforms generate combat power.[52]

PCW emphasizes stand-alone, self-sustaining, closed, and autonomous structures. As more ships, airplanes, and

[51] IATAC, 24
[52] IATAC, 24.

submarines with their respective weapons systems were being built and fielded, platform-centric warfare emerged within the military. Surface, air, and sub-surface platforms are independent, self-sustaining, and autonomous units with specified capabilities and missions.

PCW information architectures are characterized by hierarchical information flows, voice communication, limited interoperability, and stove-piped battle management systems for fires, air defense, strike, intelligence, and combat support.[53] PCW leads to rigid, top-down hierarchical organizations emphasizing centralized planning and coordinated execution across a contiguous battlefront.[54] The E-2 Hawkeye or E-3 Airborne Warning and Control System (AWACS), in counter-air operations, provides an example of PCW information flow and C2 to engage a target.

- The weapons controller onboard does not have engagement quality awareness on the objects that the E-2 or E-3 is tracking.
- The controller typically deals with a high level of uncertainty about the position of the target or insufficient information available.
- Shooter must employ sensors onboard the aircraft to develop engagement quality awareness and may be require to visually ID the target.
- All information exchange is via voice.[55]

[53] IATAC, 24.
[54] IATAC, 24.
[55] Alberts, Garstka, and Stein, 99.

During the period of information exchange, it may be difficult for the shooters and C2 nodes to maintain updated and accurate situational awareness.

Military operations are enormously complex, and complexity theory tells us that such enterprises organize best from the bottom-up.[56] Traditionally, however, military commanders work to obtain top-down command-directed synchronization to achieve the required level of mass and fires at the point of contact with the enemy.[57] Because each element of the force has a unique operating rhythm, and because errors in force movement needlessly consume combat power, combat at the operational level is reduced to a step function, which takes time and provides opportunity to the enemy.[58] After the initial engagement, there is an operational pause, and the cycle repeats.[59]

Situational awareness is one of the greatest challenges of PCW. Within PCW environment, each platform or node has a good grasp on its surroundings, but situational awareness suffers in this environment. In platform-centric military operations, situational awareness deteriorates because it is based on a sequential and

[56] Cebrowski and Garstka, 10.
[57] Alberts, Garstka, and Stein, 17.
[58] Alberts, Garstka, and Stein, 17.
[59] Alberts, Garstka, and Stein, 17.

hierarchical structure. Platforms are use to operate in a self-sustaining mode with limited interactions with other units. Though situation awareness may be reestablished periodically, PCW requires continually updating which equates to time and time is a precious commodity in military operations.

Figure 2 portrays a platform-centric engagement where sensing and engagement capabilities reside on the same platform, and there is limited capability for weapon platform to engage a target based on awareness generated by other platforms.

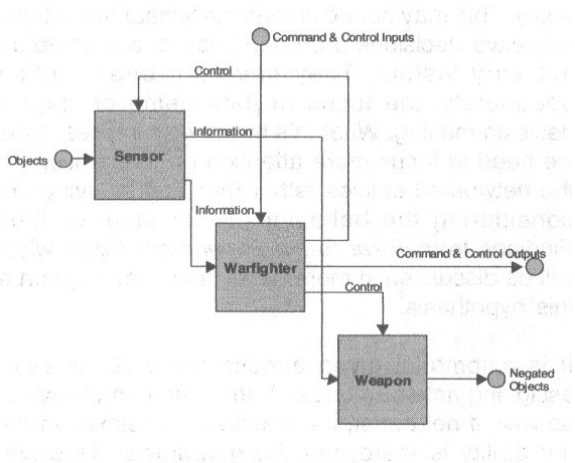

Figure 2. Platform-Centric Shooter
Source: Network Centric Warfare: Developing And Leveraging Information Superiority

Network Centric Warfare

NCW is warfare in a networked condition and dramatically increase combat effectiveness beyond that level obtained by fighting as a collection of individual platforms (i.e., platform centric).[60] NCW derives combat power from distributed interacting entities with significantly improved access to information.[61] NCW reflects and incorporates the characteristics of agility and the ability to capitalize on opportunities revealed by developing an understanding of the battle space that is superior to that developed by an adversary.[62]

The power source of NCW is the strong networking of a well-informed but geographically dispersed force. The enabling elements are:

- High-performance information grid;
- Access to all appropriate information sources;
- Weapons reach and maneuver with precision and speed of response;
- C2 processes with the flexibility to automate the assignment of resources as needed; and
- Integrated sensor grids closely coupled in time to shooters and C2 processes.[63]

NCW integrates system of sensors, information, and engagement grids that enable concepts like thin shooter,

[60] Cebrowski and Garstka, 5.
[61] Alberts, Garstka, and Stein, 93.
[62] Alberts, Garstka, and Stein, 93.
[63] Cebrowski and Garstka, 11.

speed of command, and self-synchronization and dramatically alter the way to conduct warfare.[64] Figure 3 depicts the notional architecture for NCW architecture.

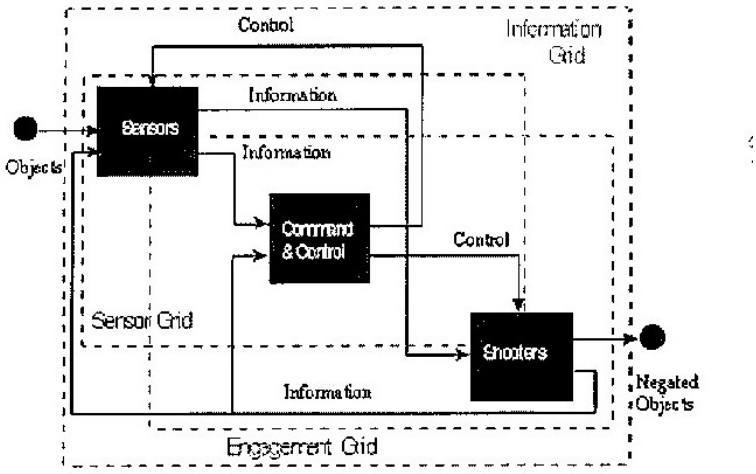

Figure 3. Notional Architecture for Network-Centric Warfare
Source: Network-Centric Warfare: Its Origin and Future

Thin shooter concept enables the decoupling of the sensor and from the shooter and coordinating the required action through the network. This concept is built on the distributed computing model where all the computing power is accessed via the network when required. This model allows units to deploy without robust computing power because it can be accessed via the network as needed.

Speed of command is the process by which a superior information position is turned into a competitive advantage. Speed of command emphasizes gaining the

[64] IATAC, 9. Thin shooter concept refers to the distribution across several platforms of capabilities that traditionally reside within single weapons/sensor platforms.

decisive edge by altering the initial condition through a high rate of change.[65] The rapid rate of change locks in success for friendly forces while locking out alternative enemy strategies.[66] Speed of command views all elements of the operating situation as parts of a complex adaptive ecosystem and achieves profound effect through the impact of closely coupled events.[67]

Self-synchronization is the C2 grid within the NCW environment. Self-synchronization is the ability of a well-informed force to organize and synchronize complex warfare activities from the bottom up.[68] The bottom up approach converts combat from a step function to a high-speed continuum.[69] The organizing principles are unity of effort, clearly articulated commander's intent, and carefully crafted rules of engagement.[70] The information age has produced tools that enable high level of knowledge of friendly forces, enemy forces, and all appropriate elements of the operating environment. Figure 3 shows the information that is available in a NCW environment.

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[65] IATAC, 11.
[66] IATAC, 11.
[67] IATAC, 11.
[68] IATAC, 11.
[69] IATAC, 11.
[70] IATAC, 11.

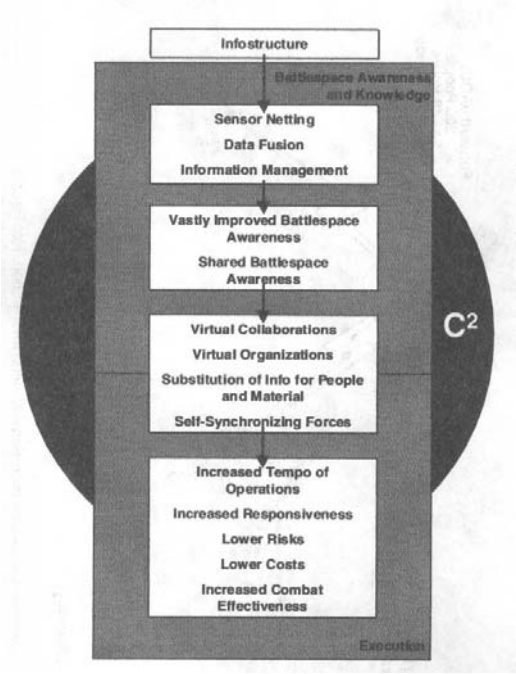

Figure 3. The Military as a Network-Centric Enterprise
Source: Network Centric Warfare: Developing and Leveraging Information Superiority

NCW emphasizes the value of the platform in the networked condition over traditional platforms in contributing to operational effectiveness.[71] NCW is applicable to all levels of warfare and contributes to the uniting of strategy, operations, and tactics. The elements of mission, force size and composition, and geography become transparent in NCW environment.[72]

NCW introduces old terminology with refined meanings. First, flexibility and adaptability is defined by the commonality of information and the availability of quality

[71] IATAC, 8.
[72] Cebrowski and Garskata, 10.

information to make timely decisions.[73] The commonality and velocity of information expands the commanders' course of actions options and streamline information collection process.

Second, disruption is defined by lock-in success for friendly forces while lockout success or limit the plans of the enemy through the increased tempo to engage.[74] A network environment could enable swarm-like attacks against the enemy through concepts like digital *schwerpunkt* and self-synchronization.[75]

Last, destroying the enemy cohesion is defined by the rapidly executed and highly synchronized physical and information assault without resorting to attrition-style campaigns.[76] The combination of these refined terms allows commanders to adapt to, and exploit, the rapidly changing battle space, leveraging friendly forces fitness while increasing the enemy friction and overall level of disorder. NCW is a mindset change where classical terminology is refined with relevant meanings.

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[73] IATAC, 12.
[74] IATAC, 10.
[75] IATAC, 10. *Schwerpunkt* was the German strategy using decentralized command to avoid mass allied forces and attach lightly defended points with a final concentration of forces at a decisive point.
[76] IATAC, 12.

Chapter 5

Transition to NCW Environment

Transition is defined as the process of changing from one form, state, activity, or place to another. The NCW concepts have been in transition since the 1900's. The early seeds of NCW concepts were sown with the birth of aircraft carrier strike operations.

> World War II has been called the sensory revolution. The best sensor, the human eye, literally took flight from the decks of ships and extended the scouting range of the fleet almost one hundred fold. For the first time naval weapons could rapidly transported hundreds of miles from their host platforms. [77]

The Battle of Midway of 1942 provides an historical example of the early benefits of NCW concepts.

> Rear Admiral Raymond A. Spruance, Commander Task Force 16, and Rear Admiral Frank J. Fletcher, Commander Task Force 17, were sortied from Pearl Harbor with the carriers Yorktown, Hornet, and Enterprise; their orders were to prevent the Imperial Navy [Japanese] from succeeding. Motivated by what [Admiral] Spruance called an "urgent need for surprise and a strong desire to hit the enemy with our full strength as early as we could reach them," the Americans began and aggressive search for the [Japanese] Combined Fleet. While the Japanese flight decks were pregnant with fuel and ordnance, the vigorous American search paid off. The rudiments of Network Centric Warfare were employed as intelligence, long-range sensors, and coordinated pulses of combat power dominated the battle. [78]

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[77] Network Centric Warfare and the Battle of Midway, URL: < http://www.alidade.net/Network_Centric_Warfare_and_Battle_of_Midway.doc >. Accessed on 06 March 2003.

[78] Network Centric Warfare and the Battle of Midway.

NCW's continued success comes from transforming the whole Navy and not only afloat units. To implement NCW concepts Navy-wide, Navy has started multiple initiatives to network afloat and ashore units together into a robust information infrastructure.

NCW concepts were not new to the afloat units. With the advent of combat information centers (CIC) during World War II, this concept was the forerunner to merging the sensors on board the ship.[79] The object of CIC was to provide the decision maker on a ship with the best possible picture of the tactical situation in which the decision maker was embedded.[80] A special radio network linked these CIC in order to exchange data with other units.

When powerful and compact computing platforms became available, the Navy was able to computerize CIC and Naval Tactical Data System (NTDS) became a reality. NTDS was the first of an almost-universal kind of naval command aid.[81] NTDS was the follow on to CIC where the successful merger of a ship's sensor data, to overcome increases in the number and the speed of potential attackers.[82] NTDS and the addition of a digital link (Link 11) between ships made

[79] Norman Friedman, "Are We Already Transformed?," *Proceedings*, January 2002, 35.
[80] Friedman, 35.
[81] Friedman, 35.
[82] Friedman, 35.

common operational picture (COP), which was precursor of the network-centric picture.[83] Joint Tactical Information Distribution System (JTIDS) and digital link (Link 16) systems on board tactical aircraft was developed to provide the same COP for pilots. NTDS and JTIDS initiatives have established the foundation for the sensor grid of the notional architecture for NCW.

Though NTDS/Link 11 and JTIDS/Links 16 networked units together within a force, the Tomahawk antiship missile targeting system was the true forerunner of NCW. The Tomahawk targeting system integrated the rich information and robust computing power ashore together with afloat units. After the study of Soviet antiship missile targeting showed that the shooter needed detailed knowledge of what other ships were present because otherwise the missile might lock on the wrong target.[84] The Navy addressed the need for situation awareness by linking dissimilar sensors that fed into shore computer systems.[85] The mid-1980's and 90's, the Navy was using remote (netted) data to practice Tomahawk shots and support the embargo against Iraq in 1990.[86]

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[83] Friedman, 35.
[84] Friedman, 35.
[85] Friedman, 35.
[86] Friedman, 35.

Cooperative Engagement Capability (CEC) is another Navy initiative to transition to NCW. The CEC generates increased battle space awareness by fusing data from multiple sensors and enabling quantum improvements in track accuracy, continuity, and identification over the information that could be achieved by using stand-alone sensors.[87] The CEC concept shows how the parts working together producing quality information that translates into increased combat power:

> CEC combines a high-performance sensor grid with a high-performance engagement grid. The sensor grid rapidly generates engagement quality awareness, and the engagement grid translates this awareness into increased combat power. This power is manifested by high probability engagements against threats capable of defeating a platform-centric defense.[88]

The Navy is also pushing the power of NCW to the desktops through Information Technology for the 21st century (IT-21) for afloat units and Navy and Marine Corp Intranet (NMCI) to shore units. Both initiatives provide the robust network infrastructure to push information to the desktops. Each initiative is key to establishing the information infrastructure to support NCW as seen in figure 5.

Though IT advances are at the center of each of these initiatives, the Navy is also implementing organizational

[87] Alberts, Garstka, Stein, 146.
[88] Cebrowski and Garskata, 11.

changes such as the establishment of Naval Network Warfare Command (NNWC) to institutionalize the changes that NCW brings. NNWC is the central operational authority responsible for coordinating all IT, information operations, and space requirements and operations within the Navy.[89]

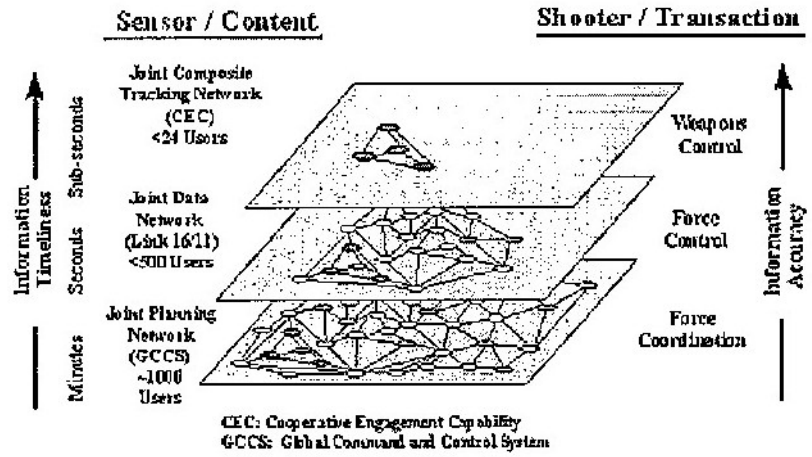

Figure 5. Emerging Architecture for Network-Centric Warfare
Source: Network-Centric Warfare: Its Origin and Future

Command and Control (C2) and NCW

The basic function or objective of command and control is to make the most of the situation and the resources at hand.[90] C2 deals with the complexity of battle.[91]

Command and Control definition is the exercise of authority and direction by a properly designated command over assigned and attached forces in the accomplishment of

[89] O'Rourke, 3.
[90] Alberts, Garstka, and Stein, 80.
[91] Alberts, Garstka, and Stein, 161.

the mission.[92] C2 is the construct that commanders use to communicate his intent and made decisions with his subordinates. C2 applies to the organizations, people, processes, and systems that enable commanders to understand a situation and provide intent, plan and/or direction. C2 is the glue to the whole NCW concept.

NCW is based on the net-centric computing concept, but also requires, and enables, and effective human element performing collaborative thinking, planning, and reacting.[93] NCW's ability to rapidly share information also promises significant improvement in a commander's ability to access a variety of reach back knowledge and data and disseminate it to the appropriate forces at the appropriate time.[94]

The current approach to C2 (and organizations) has been designed to keep the span of control within well-known human limits.[95] The traditional response to proliferation of entities requiring management is to add layers to the hierarchy, keeping the span of control manageable.[96] NCW gives commanders the ability to operate along a continuum

[92] FM 1001-5-1, MCRP 5-2A, 1-33.
[93] IATAC, 8.
[94] IATAC, 8.
[95] Alberts, Garstka, and Stein, 81.
[96] Alberts, Garstka, and Stein, 81.

of command methods, from centralize to decentralize.[97] Figure 4 depicts the options available to a commander in a NCW environment and their associated benefits and costs.

Type	Fully Centralize	Centralize Command Decentralized Execution	Collaborative C2	Decentralized C2 (Self-Synchronization	No Organization
Example	72-hour ATO	Desert Storm	Bosnia & Kosovo	Submarine Operations Guerrilla Operations SOF	Rout or Chaotic
Benefits	Optimum Use of Assets	• Near Optimum Resource Allocation • Encourages Initiative	• Higher Quality Decision Making • Units Tightly Coupled • Robust	• Low Overhead • Responsive to local situation changes	Unpredictable to Adversary
Costs	Enormous Overhead/Brittle	Potential for Mutual Interference of Missed Opportunities	• Can Be Slow to Respond • Requires Collaborative Tools and Cooperability	Highly Professional Quasi-Autonomous Units Required	• Synergy Accidental • Mutual Interference Likely

Figure 6. Information Age C2 Organizations
Source: Understanding Information Age Warfare

The information age has introduced new variables such as time reduction, distance reduction, and information availability in warfare. Often new command and control concepts arise out of a desire to leverage new capability that provides increased information.[98] An illustration of this is the emergence of the concept of Command by Negation:

> In 1972, the F-14A was introduced into the Fleet as a replacement for the F-4 as its front line Fleet air defense fighter. The F-14A had a number of significant performance advantages over the F-4, one of which was its ability to generate a superior level of onboard situational awareness. This superior situational awareness remained unexploited for 6 years while the same command and control doctrine for F-4s

[97] John D. Zimmerman, "*Net-Centric Is About Choices*," Proceedings, January 2002, 38.
[98] Alberts, Garstka, and Stein, 75.

> was used. This doctrine called for fighters to be directed to targets by controllers operating in E-2s and ship CIC with positive control enforced when available.[99]

Command by negation gave the pilot flexibility to engage the target unless otherwise directed by their operational commanders. Once the new C2, command by negation, was implemented this new approach increase combat power of the new F-14A and remove the restraint of an old system.

In the information age, one size or approach to command and control will not fit all situations.[100] The information age has set the conditions for new approaches to command and command arrangements to be implemented to effectively flatten hierarchies, free information flow (not orders) from the chain of command, and enable the enterprise to increase the speed of command to lock out adversarial options and achieve option dominance.[101] C2 is the human element of war and the advance in the information age is pushing commanders and organizations to employ the C2 systems that capitalize on the advantages gained.

[99] Alberts, Garstka, and Stein, 76.
[100] Alberts, Garstka, and Stein, 80.
[101] Alberts, Garstka, and Stein, 81.

Operational Art and NCW

Operational art is the commanders' abilities and expertise for taking strategic guidance and available resources and create a coherent joint plan that achieves the strategic aim.[102] Network Centric Warfare (NCW) is the networking of sensors, shooters, and command and control nodes on a robust information grid to obtain and maintain information superiority that translates into combat power. Synergy and synchronization of effort are key to the commander achieving the desired outcome. Net-centric operations pull the commanders' resource together in an integrated common operation picture. The integrated COP enables the commander to maintain a real-time awareness of available resources and execution mission to their fullest extent with overwhelming power.

As figure 7 illustrates, operational art is composed of many facets which the commander must take into account to effective plan and execute successful campaign plans. NCW concepts integrates the facets of operational art through concepts of self-synchronization, speed of command, and thin shooters to provide the commander with flexible options to move with speed and agile and maintain battle space awareness. NCW construct provides commanders at

[102] *The Joint Staff Officer Guide, 2000*, JFSC Pub1, 3-2.

operational and tactical level of war with real-time shared battle space awareness.

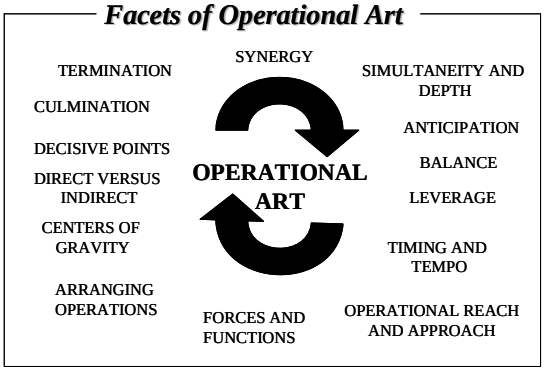

Figure 7. Facets of Operational Art
Source: The Joint Staff Officer's Guide 2000

NCW complements the basic principles of the operational art. The first principle is synergy. Synergy looks at the employment of air, land, sea, space, and special operations forces to achieve concentration in various dimensions, all culminating in attaining the assigned objectives in the shortest time possible and with minimal causalities.[103] Net-centric operations make available weapon platforms such High Speed Anti-Radiation Missiles (HARM), ATACMS, and Tomahawk cruise missiles across diverse surface combatants and geographical dispersed units increasing operational reach.

The second principle is leverage. Leverage is gaining the decisive advantage over the enemy. NCW uses

[103] JFSC Pub 1, 3-20.

information superiority to gain leverage and translate it into combat power against enemy forces. Information superiority is the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same.[104]

The last principle is timing and tempo. Timing and tempo are critical to the commander for setting conditions that exploit friendly capabilities and inhibit the enemy. NCW emphasizes timing and tempo by increasing the speed of command and locking-out the enemy's plans for execution. The locking-out concept ushers in the principle of simultaneity and depth. The intent of simultaneity and depth is to bring force to bear on the opponent's entire structure in a near-simultaneous manner that is within the decision-making cycle of the opponent.[105] Net-centric operations continuously provide the commander with a real-time COP of the operating forces to facilitate effective command and control.

The advances in technologies have shrunk the battle space and shorten the decision cycle from days to hour and minutes. As an example, in 1995, when the People's

[104] *Operational Terms and Graphics*, 30 September 1997. FM 101-5-1/MCRP 5-2A.
[105] JSFC, Pub 1, 3-20.

Republic of China attempted to influence Taiwanese elections, Vice Admiral Clemins, Commander, Seventh Fleet, and his subordinates reduced their planning timelines from days to hours through self-synchronization.[106] These technologies enable real-time battle space information to travel thousand miles away from the physical conflict areas. NCW makes real-time integrated COP available to commanders at all levels, but it will be key for commanders to remain in their respective area. Each level of war is complex, and if a decision maker abandons his level even briefly to make decisions at a lower level, effectiveness will be lost.[107]

For NCW to reach its full potential, it must be deeply rooted in operational art.[108] Both operational art and NCW occupy the same trade space, apply to all services, apply across the levels of war and the range of conflict and will be needed to maintain military dominance in the battle space.[109] Operational art provides the framework to channel the power of network centric operations.[110]

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[106] Cebrowski and Garskata, 7.
[107] Curt Copley, "A Commander's Network Centric Odyssey," Proceedings, January 2003, 58.
[108] Alberts, Garstka, and Stein, 3.
[109] Copley, 59.
[110] Copley, 59.

Chapter 6

Conclusion

Platform-centric and attrition warfare have served American military doctrine for the last twenty years, but Network centric warfare tenets and concepts are here to change how war will be fought in the future. Warfare has gone through generational changes that emphasized mass of manpower and firepower on a linear battlefield to maneuver warfare. Maneuver warfare focused on the element of surprise and indirect attack with strength against the enemy's vulnerable areas. NCW concepts were steeped in maneuver warfare tactics where speed and adaptability were essential.

The intent of this research was to determine if NCW was just new technology or new way of thinking, organizing, and fighting wars. Based on the research and analysis, it highlighted how NCW used information technology advances as an enabler to facilitate new operational concepts.

First, the holistic approach of NCW shifted combat power from independent platforms to the network. Though platforms are geographical dispersed, the power of the distributed and robust network infrastructure brought these platforms together in a synergetic effect to exponentially

multiply the commander’s available combat power. Quality battle space awareness and effective and flexible C2 were inherently built into the NCW architecture.

Second, the change from attrition to maneuver warfare emphasized an indirect approach that capitalized on the advantages gained by NCW concepts: speed of command, self-synchronization, and thin shooter.

Speed of command brought simultaneity and depth to the commander to employ forces in a synergetic approach to disrupt the opponent’s actions within the opponent’s decision-making loop. The commander’s ability to conduct operations that best exploit friendly capabilities and inhibit the enemy was enhanced through the power of networking geographical dispersed platforms and bringing them to bear when needed.

Self-synchronization addressed balance of the forces by maintaining a real-time common operational picture (COP). The COP contributed to effective C2 to allow freedom of action and responsiveness of the various platforms available to the commander. The quality battle space awareness could also helps the commander to anticipate the unexpected and exploit vulnerabilities in the opponent plans and gain a decisive advantage.

Thin shooters and robust information network increased the commander’s arsenal of capabilities. The platforms may be physically dispersed, but the quality COP gives the commander the ability to call upon these resources through the network and extend his operational reach. This capability greatly enhanced the commander’s ability to see and determine the best arrangements of operations to execute his missions in most efficient matter.

With the new operational concepts, there are some potential vulnerabilities associated with NCW.

Inherent IT problems. Networks are excellent tool to share, collaborate, and distribute information, but what happens when the network goes down? Based on the network architecture, it could significantly reduce the capabilities of the sensors, shooters, and C2 nodes. Redundancy must be built in to ensure availability and reliability during critical periods.

Security. With the increase activity of cyberspace security incidents, the protection of the network has become the highest importance. A robust security network infrastructure must be in place to ensure confidential and integrity during critical operations. Though there are challenges that must be addressed, NCW concepts complement many facets of operational art and provide a flexible and

effective C2 structure that will be key to success in future warfare.

NCW included new technology, but it was a cultural change of how the military think, organize, and fight. IT brought new means to address the challenges of warfare, but there will have to be an accompanying change of mindsets and organizational processes. Without the change of mindsets and processes, new technology would be used in old ways that does not exploit the full advantages gained by NCW concepts. Speed of command, self-synchronization, and thin shooters were not new concepts, but they must be accepted and implemented on a larger scale. NCW is the construct to facilitate change in the mindset of organizations and the individual within the organizations.

As warfare evolves from a centralized to a more decentralized model, NCW provides the adaptability and scalability required to support the spectrum of conflict from major theater wars to military operations other than war (MOOTW). NCW concepts and the information age impacts will push future commanders to think, organize and fight wars differently in the future. Joint, integrated, and combined operations and arms are the star players in future warfare, and NCW will be the mechanism of change to

facilitate and implement these elements into an effective fighting team.

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